

Atmos. Chem. Phys. Discuss., referee comment RC1
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Review of acp-2021-1005

Anonymous Referee #1

Referee comment on "Numerical simulation of the impact of COVID-19 lockdown on tropospheric composition and aerosol radiative forcing in Europe" by Simon F. Reifenberg et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1005-RC1>, 2022

The title of this manuscript suggests the authors intend to explain aerosol radiative effects during the early stages of the pandemic with reduced emissions. However, it is not clear to me that they have made a convincing case to justify the title after reading the manuscript. In particular, in the manuscript, they describe a model (nudged by meteorology) with four simulation runs targeting the period of interest. They say their model does a "reasonable" job in general, but this assertion needs further contextualization and reasoning. Overall, a reader like me is left wondering what the authors are actually trying to tell in this manuscript: Is it the "unique" measurement campaign, a "unique" model they developed to match these measurements, or fundamental new progress and understanding about aerosol radiative effects?

I cannot reasonably recommend this paper for publication without significant revision. This is not to say the work isn't valuable; it is both valuable and timely. However, the authors should improve and focus their presentation of this work to suit ACP. I look forward to their revisions.

Major points.

- What is the purpose of this paper? Is it the model only or the associated

knowledge/insight produced by this model in concert with the measurements? There is a clear disconnect between the title and introduction on the one hand and the rest of the manuscript on the other. As an example, there is a lengthy discussion of aerosol effects in the introduction, yet it is not clear how anything in the rest of the paper fills any of the many gaps in our understanding of aerosol--cloud interactions. The authors should consider shortening the introduction (pointing the reader to further material) and instead focus on what they actually address.

- The model evaluation is incomplete at best, perhaps quite weak. It can also be circular at times. The authors use a nudging technique whereby they anchor the model to some meteorology, then they evaluate the model by comparing some model outputs to aforementioned meteorology. Is that an accurate reading? Shouldn't they be the same by definition? More context and thorough explanation is needed here.
- In general, aerosol indirect effects are challenging and any work purporting to make progress in this field should be scrutinized. So please be precise and forthcoming about what this work actually brings to this field. Again, it is important and timely; so this is not to dismiss this work, but please be as precise as you could to contextualize your work.

Minor comments:

- While you are free to make up your own definitions, it is often not a good idea to make up acronyms that have other meanings in popular culture or other fields. For example, "STD" refers to sexually transmitted diseases in general, and in this manuscript, it refers to "standard" or "business as usual" --- the authors should consider unifying their approach here: They use "STD," "business as usual," and "baseline" throughout the manuscript. One would suffice, preferably the last one, "baseline."
- In many places there are added sentences that add no value to the text. For example, line 172 could be deleted; the first part of line 189 could also be deleted; lines 105--108 are unnecessary; the majority of line 157 can go as well. More on these in the list of technical comments below.

List of technical/specific comments:

- COVID-19 takes a dash, not en or em dash.
- Line 2: reads awkwardly "through direct... and indirectly," better use rephrase to use "directly ... and indirectly"
- Line 4: delete "Here"
- Line 9: delete "a somewhat"

- Line 10: delete "which could have ... campaign"
- Line 10--11: replace "a business as usual scenario" with "the baseline"
- Line 16--17: reads unclearly, maybe write: "ice crystal concentration, cloud droplet number concentration, and effect..."
- Line 19: "millions of years of life expectancy" --- not sure what the cited items say, but last time I checked, life expectancy refers to one person's life expectancy and so summing the whole planet's life expectancies to make a point is both unscientific and clumsy. I will leave it up to you to decide, but hopefully you will decide to keep the convention.
- Line 24: replace "here" with "hereafter"
- Line 27: by citing many works on air pollution and not citing a single work on climate effects, you're positioning yourself as the only paper addressing this. First, that's wrong because you're not making a convincing case here anyway about climate effects per se. Second, there are many studies about the climate effects of the lockdown. Could you please cite them and contextualize how your work differs from them?
- Line 35: replace "business as usual" with "baseline"
- Line 37: remove ", as will be ..."
- Line 43: "wavelength of the radiation" --- last time I checked this was more or less constant or basically unchanging during the lockdown, so what gives? Why do you have it here? It seems you're implying that it is changing...
- Line 50: last word, "May" --- which May? May 2020?
- Line 55: "trigger several indirect effects" --- awkward phrasing
- Line 56: "alter cloud properties" should be better phrased, maybe "can potentially alter cloud properties" or something similar
- Line 64: avoid using two symbols after each other, use the word "approximately" maybe.
- Line 99: "unique" may be a stretch.
- Lines 105--108 should be deleted
- Lines 140--149: please use something other than "STD" here.
- Line 150: Is the "binary identical dynamics" relevant to your case? If so, please say more about it here briefly.
- Lines 157--158: "led by ... with the aim of" can be deleted, the interested reader can just go read Voigt et al 2021 if they want.
- Lines 164--165: not sure if 40 micron is correct, is it? Also doesn't "aerosol particle number concentrations" cover the previous parts (e.g. ORG)? So what's going on with this list?
- Line 169: "sampled online" was the model running on the aircraft? If not, this sentence is wrong
- Line 170: What was the time step of the model? Sampling at 5 minutes seems too frequent for these types of models. Did you simply interpolate from the model time step or what is going on here?
- "Results: Model evaluation" --- either use an overarching one "Results" section or just drop the word "results" from sections 3 and 4.
- Line 172 can go.
- Lines 173--178 can also go; you should generally address the model validation better and this paragraph doesn't do you any service.
- Lines 179--181: yes, exactly. So maybe a different evaluation is needed
- Line 182: "is not surprising" to whom? You could be more precise here
- Line 189: "Observed ... by the model" should go
- Line 193: "within a factor of two" --- is that any good? If so, please explain. If not, also please explain. In general give more context to these ranges, otherwise they can be interpreted differently by different people. For example, a factor of two is really bad in my opinion...
- Line 194: delete "somewhat"
- Add readable legends to Figure 2.
- Line 206: "hypothesize" --- please say more. Can we test this hypothesis? If so, how?

- Line 212: delete "The vertical ... reproduced (see Fig. 3)." Also "quantitatively" in what sense? Can you qualify that more if you want to keep it?
- Lines 223--226: Please either list these volcanoes of interest (obviously super important; you do list some of them later, e.g. Line 243) or don't leave vague language like this around. This could be an opening for you to improve the manuscript anyway
- Line 232: "We conclude that" --- can you give your reasoning to this conclusion? Is it a conclusion anyway or an observation at this stage?
- Figure 3 like Figure 2 (add legends)
- Figure 4: please make it bigger and clarify it.
- Line 250: "Results" again, see my above comment about "results"
- Line 257: these are not "purely attributable" to differences in your model or are not well captured by it, correct?
- Line 266: "most tracer" should be "most tracers"
- Lines 270--271: please elaborate more on this.
- Figure 5: add legends and make bigger
- Line 284: "monthly mean sulfate (and inorganic aerosols, not show) and black" should be rephrased
- Line 286: "lockdown scenario" please unify your naming.
- Line 299: these are not really close values, are they? They are within the range of error. What's the range of error for the second value btw?
- Line 302: is that significant?
- Line 335: "We should note" instead of "We should notice"
- Line 360: Could you reflect on this range a little more? Seems insignificant and uncertain to a casual reader.
- Code availability: Why list all these details about doing MOU and all that, can you just give the git repository link and tag/commit?
- Data availability: Please make your data available, and refrain from "contact the author" stuff. It doesn't seem open...